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底比斯釉小蜂 (*Chrysocharis pentheus* (Walker)) (膜翅目：釉小蜂科) 之形態與生活史

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摘　　要

底比斯釉小蜂 (*Chrysocharis pentheus* (Walker)) 行單產雄性孤雌生殖、單員內寄生。未交尾雌蜂之生育力與致死寄主能力較交尾者各降低 81.8 與 66.2%。該蜂以產卵寄生 (65.1%) 與取食寄主 (34.9%) 之方式致死蔬菜斑潛蠅 (*Liriomyza sativae* Blanchard)。寄主幼蟲被產卵或取食後，各經 3.9 ± 0.4 與 0 分鐘，即不再活動、取食，各自呈現深度麻痺與死亡狀態。羽化高峰期為上午 5 至 7 點間，產卵與取食寄主高峰期均為上午 5 點至下午 1 點間。雌蜂偏好在寄主第三齡幼蟲上產卵與取食。該蜂在 25℃下，卵至蛹期發育所需時間為 13.2 ± 0.1 日，其中卵期為 1.4 ± 0.0 日，幼蟲期為 4.3 ± 0.1 日，前蛹期為 0.7 ± 0.1 日，蛹期為 6.8 ± 0.1 日。卵發育至蛹期之存活率為 95.5 ± 2.1%。每日供應 40～50 隻第三齡寄主幼蟲與純蜂蜜時，雌、雄蜂壽命各為 21.9 ± 1.3 與 16.1 ± 1.3 日，每雌蜂可產 220 ± 32 隻子蜂，並致死寄主 358 ± 48 隻。子代雌性比為 0.50 ± 0.03。

關鍵詞：底比斯釉小蜂、蔬菜斑潛蠅、外部形態、生活史、菜豆。

前　　言

底比斯釉小蜂 (*Chrysocharis pentheus* (Walker)) 屬膜翅目 (Hymenoptera)、釉小蜂科 (Eulophidae)。於 1839 年由 Walker 定名爲 *Entedon pentheus* (Walker, 1839)，但學名歷經多次變動 (詳見附表一)。該蜂分布於北美之加拿大與美國，歐洲之挪威、瑞典、芬蘭、丹麥、英國、海峽群島 (Channel Is.)、荷蘭、德國、捷克、波蘭、烏克蘭、蘇聯、法國、瑞士、奧地利、斯洛伐克、匈牙利、羅馬尼亞、摩爾多瓦、南斯拉夫、塞爾維亞、克羅埃西亞、西班牙、加那利群島、義大利、保加利亞、馬其頓及希臘，中東之土耳其、賽普勒

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斯及以色利，亞洲地區之馬來西亞、越南、中國 (山東、江西、浙江、廣東、雲南及海南)、臺灣、日本、韓國及北韓等地 (附表二)。多食性，寄主範圍包括雙翅目 62 種、鱗翅目 102 種、鞘翅目 11 種及膜翅目 3 種 (附表二)。在臺灣與中國爲蔬菜斑潛蠅 (*Liriomyza sativae* Blanchard) 田間之優勢寄生蜂，在日本亦爲非洲菊斑潛蠅 (*Liriomyza trifolii* (Burgess))、毛茛潛葉蠅 (*Phytomyza ranunculi* Schrank)、食蜜潛葉蠅 (*Chromatomyia lonicerae* (Robineau-Desvoidy))、桃潛葉蛾 (*Lyonetia clerkella* (L.)) 及柑桔潛葉蛾 (*Phyllocnistis citrella* Stainton) 等之田間優勢寄生蜂 (附表二)。底比斯釉小蜂搜尋寄主時，採取專注於搜尋特定區域之方式 (a fixed search-effort, an area-concentrated search) (Sugimoto and Tsujimoto, 1988)；寄生方式屬幼蟲單員內寄生，致死寄主方式有寄生與取食寄主 (host-feeding) 兩種，雌蜂產卵與取食寄主時，均偏好第三齡非洲菊斑潛蠅幼蟲 (Chien and Ku, 2001)。爲瞭解底比斯釉小蜂對蔬菜斑潛蠅之抑制能力，本研究以該蠅爲寄主，觀察此蜂之外部形態與生活史，藉以提供該蜂辨識、繁殖方法、及生物防治時評估寄生蜂對寄主防治潛能之參考。

材料與方法

供試蟲源

在南投縣林內鄉敏豆 (*Phaseolus vulgaris* L.) 上，採集被蔬菜斑潛蠅幼蟲危害之葉片，攜回室內。攤開葉片，稍陰乾後，再分裝於有透氣孔之封口塑膠袋。待斑潛蠅成蠅與底比斯釉小蜂羽化，供做後續試驗飼育之蟲源。

供試寄主植物、寄主害蟲及寄生蜂之繁殖

本試驗所用之寄主植物菜豆苗 (*Phaseolus vulgaris* var. *communis* Aeschers) 之栽培，與供試寄主蔬菜斑潛蠅之繁殖，係參照 Chien and Ku (1996) 之方法。底比斯釉小蜂之繁殖則參照 Chien and Ku (2001) 之方法，以帶有寄主第三齡蔬菜斑潛蠅幼蟲潛食之罐插菜豆苗，繁殖底比斯釉小蜂。

一、各蟲期之外部形態

在 25℃下，參照 Chien and Ku (2001) 之方法，上午 8 點將 30 隻雌蜂釋入直徑 20 cm、高 25 cm 壓克力筒內，再供應內有 120 隻第三齡寄主幼蟲潛食之罐插菜豆苗 (每葉 30 隻)，待雌蜂產卵 2 小時後，將罐插菜豆苗移出。繼之，在溫度 25℃、相對濕度 65～85% RH 及光週期 12 L:12 D (上午 5 點至下午 5 點間照光) 下，觀察底比斯釉小蜂各蟲期之外部形態，各觀察 20～30 隻。並以立體顯微鏡 (Wild，接目鏡 20 ×、接物鏡 5 ×) 中之測微尺，直接測量各蟲期之體型大小，及藉幼蟲頭寬判定幼蟲之各齡期，各觀察 20 及 9～20 隻。

二、發育各期之時間與過程

於前項外部形態觀察之試驗中，同時亦每日觀察 25℃ 下，該蜂各蟲期之存活率與發育日數，並在近各蟲期變化或齡期蛻皮之際，每小時記錄該蜂之發育情形。其中存活率試驗，25～35 粒卵爲一組，計 3 重複；發育期試驗各觀察 20～23 隻不等。

三、成蜂行為

羽化：2006 年 4 月在 25℃、相對濕度 65～85% RH 及自然光照下，觀察室內飼養釉小蜂之羽化方式，並記錄一日內，該蜂每小

時之羽化蟲數及其性比。觀察蟲數爲 200 隻。

交尾：在前述相同條件下，將單個蛹分別置於直徑 1.5 cm、高 7 cm 之指形管內，待釉小蜂羽化後，加以配對，移入另一指形管內，供食未稀釋之純蜂蜜，並觀察其交尾前期、交尾方式及交尾時間，各進行 22、30 及 13 重複。

產卵與取食寄主：參照 Chien and Ku (2001) 之方法，先準備帶有寄主第三齡幼蟲潛食之罐插菜豆苗，將其置入直徑 20 cm、高 25 cm 之壓克力筒內。在 25℃ 下，再將已交尾雌蜂釋入，觀察雌蜂之產卵方式與時間，以及取食寄主之方式與時間。各進行 17 與 14 重複。產卵時刻與取食寄主時刻之觀察，則在 25℃、光週期 12 L:12 D (上午 5 點至下午 5 點間照光) 下，自清晨 1 點起至次日凌晨 1 點止。在直徑 12 cm、高 21 cm 玻璃筒內，每隔 4 小時，更換內有 40 隻寄主第三齡幼蟲潛食之罐插菜豆苗，供 1 隻已有產卵、取食經驗之第三日齡雌蜂 (羽化後第四天) 產卵與取食。並依 Chien and Ku (2001) 之方法，記錄雌蜂於各處理時段內之產卵寄生數與取食寄主數。計 14 重複。

無選擇性試驗時，先準備各帶有 20 隻第一、二、或三齡寄主幼蟲之 1 片罐插菜豆葉片，將其各置入接蜂用玻璃筒內 (直徑 12 cm、高 22 cm)。而選擇性試驗時，則先準備各帶有 10 隻第一齡、10 隻第二齡及 10 隻第三齡寄主幼蟲之 3 片罐插菜豆葉片，將其置入前述相同大小之接蜂用玻璃筒內。然後在 25℃ 定溫下，釋入第四或第五日齡已有產卵經驗之雌蜂 1 隻，任其產卵。各處理雌蜂產卵時段，爲上午 9 點至下午 1 點之 4 小時，其後將已接過蜂之帶蟲罐插菜豆葉片移出。次日，利用透光法，先計數雌蜂對各豆葉內不同齡期寄主幼蟲之總致死數 (寄生數 + 取食寄主數)；7 天後，再分別記錄雌蜂對不同齡期寄主幼蟲之寄生數 (寄生蜂蛹數) 與取食寄主數 (總致死寄主數 − 寄生蜂蛹數)；待寄生蜂羽化後，再記錄雌蜂與雄蜂數及雌性比〔雌蜂數 ÷ (雌蜂數 + 雄蜂數)〕。無選擇性試驗每一處理組各進行 11～23 重複，選擇性試驗進行 16 重複。

交尾對繁殖力與致死寄主力之影響：試驗分兩種方式進行，即分別爲未交尾雌蜂 1 隻，與終生在一起交尾 1 或 1 次以上之雌、雄蜂 1 對。在 25℃ 下，自該蜂羽化當日起，將供試蜂釋入前述大小之接蜂用玻璃筒內，每處理每日供應 1 株內有 40～50 隻寄主第三齡幼蟲潛食之罐插菜豆苗外，尙以細毛筆將純蜂蜜塗於玻璃筒內壁，直至雌蜂死亡爲止。記錄其間處理組雌蜂之壽命、子蜂數、子代雌性比〔雌蜂數 ÷ (雌蜂數 + 雄蜂數)〕、寄生致死寄主蟲數、取食致死寄主蟲數、及寄生致死寄主數與取食致死寄主數之比值，各進行 17 與 11 重複。

四、統計分析

各項試驗資料除利用 SPSS (Statistical Products and Services Solutions) 軟體先進行變方分析，再以最小顯著差 (LSD) 法、或 t 值測驗法檢測，採 $p < 0.05$ 顯著水準比較處理間之差異性。其中雌蜂對寄主同一齡期產卵或取食之偏好性試驗，是以配對樣本 t 檢定統計分析。而雌蜂交尾對繁殖力與致死寄主能力之試驗，除雌蜂壽命是採獨立樣本 t 檢定中變方相等之統計分析外，其他均採獨立樣本 t 檢定中變方不等之統計分析。

結　果

一、外部形態

成蜂：雌、雄成蟲體黑色，體背具明顯的銅綠色金屬光澤（圖一 A）；複眼均爲紅褐色；前、後翅均爲透明、僅前翅之痣脈（stigmal vein）爲黑色。頭部具粗網皺；複眼內緣不內凹；觸角膝狀，柄節（scape）長且側扁，梗節（pedicel）圓筒形，鞭節（flagelleum）由環節（ring segments）2 節、絲節（funicle）3 節及錘節（club）2 節所組成，環節小而不明顯，錘節長度約爲絲節總長之 0.42，末節端部有端刺。胸部，中胸背板的中胸楯片（mesoscutum）在兩側中央近盾縱溝（parapsidal groove）處稍呈凹陷；前翅翅脈退化，無翅室，前翅後前緣脈較痣脈長 1.8 倍；各足跗節均爲 4 節。腹部較光滑，第一節之外，各節均具疏毛。雌、雄之診斷特徵：體型，雌蟲大於雄蟲（表一）。雌蟲的觸角柄節，呈透明灰白色，其餘各節爲暗褐色；雄蟲的觸角除柄節爲淡褐色外，其餘各節爲暗褐色。雌蟲各足基節暗褐色，其餘各節爲灰白色，後足腿節上半部稍具褐斑，爪呈暗褐色；雄蟲各足基節暗褐色，其餘各節縞黃色，後足腿節上半部稍具褐斑，爪呈暗褐色。雌蟲的前伸腹節中脊呈 T 形；雄蟲的前伸腹節中脊則呈 Y 形。雌蟲第六腹節腹板中央即爲產卵管；雄蟲陰莖則明顯外露。

卵：透明、無色、長橢圓形（圖一 B）。卵大小見表一。

幼蟲：幼蟲共有 4 個齡期。各齡頭寬與大小見表一。第一齡幼蟲體透明、無色，略呈直筒形，腹部消化管內僅含少許黃褐色內容物。第二、三齡幼蟲體透明、無色，略呈紡錘形，腹部消化管內褐色內容物增多。第四齡幼蟲體透明、無色，呈長紡錘形，腹部消化管內之內容物暗褐色（圖一 C）。

前蛹：體乳白色（圖一 E）。體型大小見表一。

蛹：體黑色、複眼與單眼黑色（圖一 F）。體型大小見表一。

二、發育之時間與過程

底比斯釉小蜂在 25℃ 下，自卵發育至蛹期需時 13.2 ± 0.1 日（n = 20）。其中卵期爲 1.4 ± 0.0 日（n = 23）；幼蟲期爲 4.3 ± 0.1 日（n = 23），第一至四齡幼蟲發育所需時間各爲 0.8 ± 0.0 (n = 23)、0.6 ± 0.0 (n = 23)、0.2 ± 0.0 (n = 23) 及 2.7 ± 0.1 (n = 23) 日；前蛹期爲 0.7 ± 0.1 日（n = 23）；蛹期爲 6.8 ± 0.1 日（n = 20）。卵發育至蛹期之存活率爲 95.5 ± 2.1%，其中卵、幼蟲、前蛹及蛹期之存活率各爲 98.8 ± 1.3、99.3 ± 0.8、98.8 ± 1.2 及 98.8 ± 1.3%。卵產在寄主體內，行單員內寄生（圖一 K）。雌蜂能辨識寄主是否已被寄生之能力，每一寄主體內之蜂卵數多爲 1 粒，但若蜂卵數超過 1 粒以上時，雖均能孵化，但僅 1 隻第一齡幼蟲存活。初孵化之第一齡幼蟲在寄主幼蟲體內取食。該蜂第一至二齡幼蟲之取食量很少，待該蜂發育至第四齡幼蟲時食量始大增，經 1.9 ± 0.1日（n = 23），將寄主體液吸盡，此時幼蟲鑽出寄主體外，並沿著先前寄主潛食過之隧道，爬行 2.85 ± 0.04 mm (0.4～7.3 mm, n = 20)，靜止不動，經 0.8 ± 0.0 日（n = 23）後，全身緊縮，隨之排出褐色之排泄物進入前蛹。而寄主則僅剩一層薄薄之外皮（圖一 L)。老熟幼蟲之排泄物呈圓柱形（直徑 0.11～0.18 mm、高 0.15～0.33 mm），共 1～6 粒，分置蟲體左右，近似對稱排列，其中排出 4、5 及 6 粒之發生率各爲 26.7、26.7 及 36.7% (n = 60)，此結構可頂住豆葉被寄主潛食後所殘留之上下表皮，供老熟幼蟲在此空

圖一　底比斯釉小蜂之各生長期及其致死寄主之方式。A. 產卵寄生中之雌蜂；B. 卵；C. 第四齡幼蟲；D. 老熟幼蟲利用排泄物架構化蛹場所；E. 前蛹；F. 蛹；G. 正常之寄主幼蟲；H. 被產卵後麻痺狀態之寄主； I. 取食寄主中之雌蜂；J. 被雌蜂取食致死之寄主；K. 寄生蜂幼蟲取食寄主；L. 被寄生後已乾癟之寄主。

Fig. 1. Appearance and host-killing mode of *Chrysocharis pentheus*. A. female wasp parasitizing a leafminer; B. egg; C. 4th instar larva; D. mature larva using its excreta to construct a pupation site; E. prepupa; F. pupa; G. normal host larva; H. host-paralyzed after oviposition; I. female wasp feeding on a leafminer; J. a host killed by wasp feeding; K. larva feeding on a host; L. host-killed by parasitism.

間內發育為前蛹與蛹 (圖一 D)。前蛹經 0.7 ± 0.1 日變為白蛹。待 2.8 ± 0.1 小時後，蛹體由乳白色變黑，再經 4.0 ± 0.1 日羽化為成蜂。

三、成蜂行為

羽化：蜂蛹發育成熟後，成蜂先咬破其黑色蛹皮鑽出，隨即在原化蛹處豆葉之上表皮，咬一直徑 0.35 ± 0.02 mm 之圓洞鑽出 (n =

表一　在 25℃下底比斯釉小蜂各蟲期體型大小

Table 1. Body size of the various stages of *Chrysocharis pentheus* at 25°C

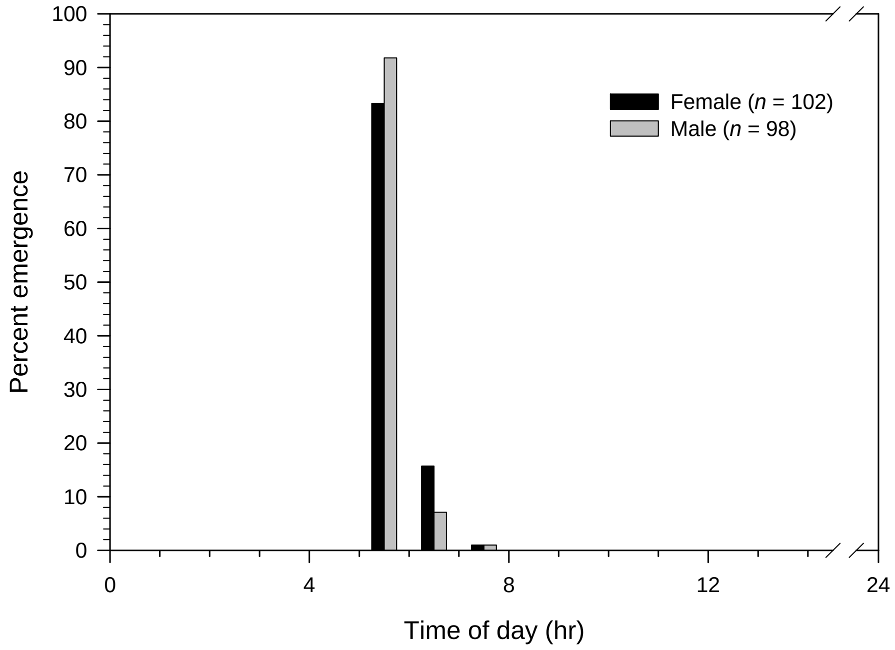
Stage	Head width (mm)		Body size (mm) ($\bar{X}$ ± SEM)		
	n	$\bar{X}$ ± SEM	*n*	Length	Width
Egg			20	0.24 ± 0.00	0.08 ± 0.00
Larva					
1st	20	0.06 ± 0.00			
Early			20	0.36 ± 0.00	0.12 ± 0.01
Late			20	0.51 ± 0.00	0.18 ± 0.00
2nd	9	0.15 ± 0.00			
Early			20	0.57 ± 0.00	0.22 ± 0.00
Late			20	0.65 ± 0.00	0.26 ± 0.00
3rd	17	0.18 ± 0.00			
Early			20	0.77 ± 0.01	0.30 ± 0.00
Late			20	1.11 ± 0.00	0.40 ± 0.00
4th	20	0.22 ± 0.00			
Early			20	1.24 ± 0.01	0.46 ± 0.00
Late			20	1.81 ± 0.03	0.68 ± 0.01
Prepupa			20	1.31 ± 0.03	0.51 ± 0.01
Pupa			20	1.61 ± 0.03	0.62 ± 0.01
Adult					
Female			20	1.45 ± 0.02	0.40 ± 0.01
Male			20	1.18 ± 0.02	0.32 ± 0.01

17)。羽化時刻為早上 5 至 8 點間，但 99.0% 集中於早上 5 至 7 點間 (*n* = 200)，雄蜂與雌蜂羽化時刻相同（圖二）。雌、雄性比為 0.51 : 0.49。

交尾：羽化後 3.6 ± 0.2 小時即可交尾 (*n* = 22)。交尾時，雄蜂揮動觸角尋找雌蜂，觸及雌蜂後即爬上其背，然後身軀退後彎曲腹部與雌蜂交尾。每次交尾時間需 16.7 ± 1.0 秒 (12～24 秒，*n* = 13)。

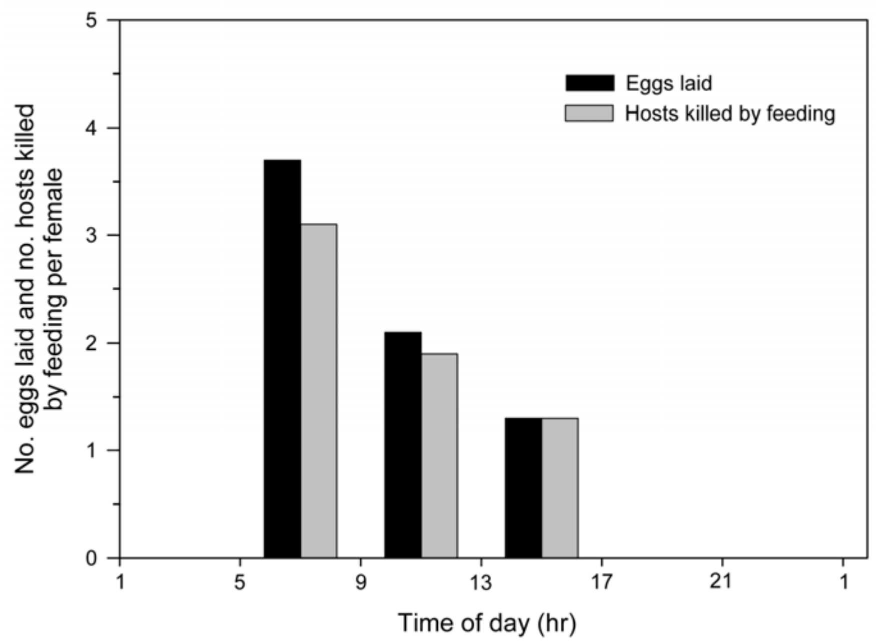
產卵：產卵時，雌蜂在豆葉上一面行走，一面揮動觸角尋找潛食在豆葉內之寄主，若探觸到適齡寄主幼蟲時，雌蜂即下壓腹部，將產卵管刺向豆葉內之寄主，並將卵產下。產卵需時 48.9 ± 2.2 秒 (34～62 秒，*n* = 17)。產卵時刻為早上 5 點至下午 5 點間，但 81.7% 集中於早上 5 點至下午 1 點間 (*n* = 14)（圖三）。寄生寄主方式為單員內寄生。雌蜂產卵時，寄主幼蟲即停滯不取食，待雌蜂產完卵離開後，寄主雖恢復取食並向前蠕動，但其口鉤之取食速度即趨緩，經 3.9 ± 0.4 分鐘後 (*n* = 30)，口鉤即完全不動，停止取食，體膚鬆馳、身體拉長、雖經刺激但無反應呈深度麻痺狀態，再經 1.2 ± 0.1 小時後 (*n* = 30)，寄主幼蟲消化管內之暗綠色內容物，亦大致排清或完全排清（圖一 H）。而未被寄生之寄主，體軀則渾圓活動力強、口鉤活動不停、體內消化管內暗綠色之內容物明顯（圖一 G），僅幼蟲近老熟前，體軀才不大蠕動、體內消化管內之暗綠色內容物方減少。

取食寄主：雌蜂有取食寄主行為。取食寄主時，雌蜂先藉產卵管透過豆葉鑽刺寄主幼蟲之體表，再以口器在該鑽刺處取食寄主幼蟲之體液（圖一 I），此鑽刺與吸食動作重複為之，次數各達 12.5 ± 1.7 與 10.4 ± 1.8 次 (*n* =



圖二　在 25℃ 下底比斯釉小蜂之羽化時間。

Fig. 2.　Daily emergence rhythm of *Chrysocharis pentheus* at 25°C.



圖三　底比斯釉小蜂雌蜂在 25℃ 與光週期 (上午 5 點至下午 5 點間照光) 下之產卵與取食時刻。

Fig. 3.　Daily oviposition and host-feeding rhythm of female *Chrysocharis pentheus* at 25°C and 12 hrs of photophase set from 5:00 a.m. to 17:00 p.m. in a growth chamber.

表二　底比斯釉小蜂對蔬菜斑潛蠅幼蟲齡期之偏好性

Table 2. Preference of *Chrysocharis pentheus* for various instars of *Liriomyza sativae*

Instars of leafminer	No-choice test[1,3)]		Free-choice test[2,3)]	
	No. of hosts parasitized	No. of hosts killed by feeding	No. of hosts parasitized	No. of hosts killed by feeding
1st	0Ab	0.1 ± 0.1Ab	0 b	0c
2nd	0.3 ± 0.2Bb	5.4 ± 0.5Aa	0.2 ± 0.1Bb	1.2 ± 0.5Ab
3rd	9.8 ± 1.0Aa	4.6 ± 0.6Ba	4.9 ± 0.4Aa	2.6 ± 0.4Ba

1) In each treatment 20 larvae of *L. sativae* were provided in an acrylic cylinder (20 cm diameter, 25 cm high) under 25°C, 12L:12D, and 65-85% RH. Eleven to twenty three replicates.

2) In each treatment, 10-1st instars, 10-2nd instars and 10-3rd instars of *L. sativae* were provided in an acrylic cylinder (20 cm diameter, 25 cm high) under 25°C, 12L:12D, and 65-85% RH. Sixteen replicates.

3) Means ($\bar{X}$ ± SEM) within each row followed by the same uppercase letter are not significantly different (p < 0.05, paired samples t-test). Means ($\bar{X}$ ± SEM) within each column followed by the same lowercase letter are not significantly different (p < 0.05, LSD).

表三　交尾與未交尾底比斯釉小蜂雌蜂之生育力與致死寄主能力[1,2)]

Table 3. Fertility and host-killing capability ($\bar{X}$ ± SEM) of mated and unmated females of *Chrysocharis pentheus*[1,2)]

Mating frequency	*n*	Longevity (d)		Fertility/female		No. of hosts killed/female			
		Female	Male	No. adult	Female proportion	Parasitized	Feeding	Total	Parasitized/ feeding
0	17	16.1 ± 1.3b	-	40 ± 6b	0b	50 ± 8b	71 ± 8b	121 ± 15b	0.69 ± 0.07b
> 1	11	21.9 ± 1.3a	15.1 ± 1.6	220 ± 32a	0.50 ± 0.03a	233 ± 33a	125 ± 20a	358 ± 48a	2.02 ± 0.21a

1) Female wasp was provided with 40-50 third instars of *L. sativae* daily at 25°C.

2) Means within each column followed by the same letter are not significantly different (p < 0.05, t-test).

14)。雌蜂每次取食寄主需 3.6 ± 0.3 分鐘，其中鑽刺寄主需時 2.7 ± 0.3 分鐘，吸食寄主體液需時 0.9 ± 0.1 分鐘 (n = 14)。取食寄主活動時刻爲早上 5 點至下午 5 點間，但 79.4% 集中於上午 5 點至下午 1 點間 (n = 14) (圖三)。雄蜂未見取食寄主現象。寄主幼蟲一被取食即刻死亡 (n = 30)。此時其外形伸長、體扁略萎縮、體表被取食傷口處留有乾涸之體液，口鉤不動，體內體液減少且較不流動、消化管內仍殘留有暗綠色之內容物 (圖一 J)。

寄主齡期之偏好性：雌蜂對寄主之寄生與取食數，受寄主齡期影響。若以寄主不同齡期比較時，在無選擇性試驗中，雌蜂顯著偏好在第三齡幼蟲上產卵、第二與第三齡幼蟲上取食；但在有選擇性試驗，雌蜂顯著偏好在第三齡幼蟲上產卵與取食 (表二)。如以寄主同一齡期比較時，不論在無選擇性或有選擇性試驗時，雌蜂在第一齡寄主幼蟲完全不寄生，亦幾乎不取食；在第二齡寄主幼蟲上，雖可少量寄生，卻顯著偏好取食；在第三齡寄主幼蟲上，則顯著偏好寄生 (表二)。

雌蜂交尾對繁殖力與致死寄主能力之影響：雌蜂在未交尾、或終生與雄蜂在一起交尾 1 次以上時，兩處理間不論雌蜂之壽命、寄生寄主數、取食寄主數、致死寄主總數、寄生與取食致死寄主比值、子代數及子代雌性比等均有顯著差異 (表三)。如未交尾雌蜂之子蜂數與致死寄主數僅各爲 40 與 121 隻，且子代均

附表一　底比斯釉小蜂（*Chrysocharis pentheus* (Walker, 1839)）之學名變動表
Appendix 1.　Synonymic list of *Chrysocharis pentheus* (Walker, 1839)

Species name	References
Chrysocharis (*Kratochviliana*) *pentheus* (Walker, 1839)	1, 2, 3, 5
Chrysocharis aquilegiae Erdös, 1961	2, 3, 4, 5
Chrysocharis orientalis (Girault, 1917)	1
Chrysocharis pallipes (Gahan, 1917)	4, 5
Chrysocharomyia elegantissima Girault, 1917	1
Derostenus pallipes Gahan, 1917	3, 4, 5
Entedon ergeteles Walker, 1848	4, 5
Entedon ergetelis Walker, 1848	1, 2, 3, 4, 5
Entedon pentheus Walker 1839	1, 2, 3, 4, 5
Epilampsis mirabilis Sundby, 1957	1, 2, 3, 4, 5
Epilampsis pentheus (Walker, 1839)	5
Kratochviliana pentheus (Walker, 1839)	5
Omphalchrysocharis orientalis Girault, 1917	1

References: 1. Yoshimoto (1973). 2. Hansson (1985). 3. Hansson (1987). 4. Noyes (2002). 5. Universal Chalcidoidea Database (2007).

爲雄性。而交尾雌蜂之子蜂數與致死寄主數，除各高達 220 與 358 隻，子代雌性比亦達 0.5。

討論與結論

一、寄主與地區對底比斯釉小蜂發育之影響

底比斯釉小蜂爲分布廣泛、具多食性之寄生蜂（附表二）。在臺灣與中國，爲蔬菜斑潛蠅田間之優勢蜂種，在日本，爲非洲菊斑潛蠅、毛莨潛葉蠅、食蜜潛葉蠅、桃潛葉蛾及柑桔潛葉蛾等之田間優勢蜂種（附表二）。本試驗該蜂在 25℃、菜豆上寄生蔬菜斑潛蠅時，其卵至蛹期發育所需時間（13.2 日），雖與在 26℃、豇豆上寄生蔬菜斑潛蠅時之日數（12.53 日）近似（Zhan *et al*., 2002），但卻與在 25℃、毛莨（*Ranunculus glaber* Makino）上寄生毛莨潛葉蠅時之日數（16.0 日）(Sugimoto *et al*., 1982）有差距。另寄生於蔬菜斑潛蠅與桃潛葉蛾（Adachi, 1998）後，子代雌蜂體長均爲 1.45 mm；寄生於蔬菜斑潛蠅與非洲菊斑潛蠅後，雌性比亦近似，各爲 0.5 與 0.5～0.55 (Arakaki and Kinjo, 1998)。顯示底比斯釉小蜂在不同地區、面對不同寄主，其確爲一適應性強之寄生蜂。

二、底比斯釉小蜂生殖方式

本試驗結果得知，底比斯釉小蜂未交尾雌蜂，雖可產下少數有活力之卵，但子代均爲雄性，顯示該蜂生殖方式爲單產雄性孤雌生殖。同時未交尾雌蜂之生殖力與致死寄主能力，較交尾者各大幅降低 81.8 與 66.2%。

三、底比斯釉小蜂致死寄主策略

由 Chien and Ku (2001) 與本試驗結果得知，不論在非洲菊斑潛蠅或蔬菜斑潛蠅上，底比斯釉小蜂致死寄主方式，有產卵寄生與取食寄主兩種，且均偏好第三齡寄主幼蟲。同時在 25℃ 下，其產卵寄生與取食寄主之比例爲 2.02:1，顯示雌蜂寄生致死寄主之能力較取食強。又寄主幼蟲被產卵或取食後，各經 3.9 與 0 分鐘，即不再活動、取食，且分別呈現深度

附表二　底比斯釉小蜂寄主、分布及發生之世界記錄

Appendix table 2. World host, distribution and occurrence of *Chrysocharis pentheus*

Host	Distribution	Occurrence	References
DIPTERA 雙翅目			
Agromyzidae 潛蠅科			
Agromyza albipennis Meigen	Japan		Kamijo, 1978; Ikeda, 1996
A. alnibetulae Hendel	-		Universal Chalcidoidea Database, 2007
A. aristata Malloch	Canada		Hansson, 1987
A. demeijerei Hendel	Sweden		Hansson, 1985
A. flaviceps Fallen	Sweden		Hansson, 1985
A. hiemalis Becker	Italy		Massa and Rizzo, 2000
A. nana Meigen	Sweden		Hansson, 1985
A. orobi Hendel	Sweden		Hansson, 1985
A. oryzae Munakata	Japan		Kamijo, 1978
A. rufipes Meigen	Sweden		Hansson, 1985
Amauromyza flavifrons (Meigen)	Sweden		Hansson, 1985
Calycomyza humeralis Roser	Japan		Kamijo, 1978
Chromatomyia fuscula (Zetterstedt)	Norway		Hagvar *et al*., 1998
C. horticola (Goureau)	China (Guangdong)		Zeng, *et al*., 1999
	China (Yunnan)		Zhu *et al*., 2006
	China (Zhejiang)		Chen *et al*., 2003
	Japan	dominant	Saito, 2004; Larios *et al*., 2007
C. lonicerae (Robineau-Desvoidy)	Japan	majority	Kato, 1984; Ikeda, 1996
Liriomyza spp.	Vietnam		Tran *et al*., 2006
L. bryoniae (Kaltenbach)	China (Guangdong)		Zeng, *et al*., 1999
L. chinensis (Kato)	China (Zhejiang)		Chen *et al*., 2003
L. eupatorii (Kaltenbach)	Sweden		Hansson, 1985
L. huidobrensis (Blanchar)	China (Guangdong)		Zeng, *et al*., 1999
	Taiwan		Chien and Chang, unpublished
L. impatientis Brichke	-		Universal Chalcidoidea Database, 2007
L. sativae Blanchard	China (Hainan)	predominant	Cai *et al*., 2005
	China (Guangdong)	predominant	Xu *et al*., 1999; Zeng, *et al*., 1999; Liang *et al*., 2001; Zhan *et al*., 2002; Ren *et al*., 2006
	China (Zhejiang)		Chen *et al*., 2003
	China (Shandong)	predominant	Zhao *et al*., 2003
	Taiwan	predominant	Chien and Chang, unpublished
L. trifolii (Burgess)	Israel		Freidberg and Gijswijt, 1983

附表二　（續）
Appendix table 2.　continued

Host	Distribution	Occurrence	References
	Japan	predominant	Arakaki and Kinjo, 1998; Hondo *et al*., 2006
	Taiwan		Lin and Wang, 1992; Chien and Ku, 1998
L. huidobrensis (Blanchar)	Malaysia, Vietnam		Murphy and LaSalle, 1999
Paraphytomyza cornigera Griffiths	Canada		Hansson, 1987
P. hendeliana (Hering)	Sweden		Hansson, 1985
P. orbitalis Melander	USA		Hansson, 1987
P. populi (Kaltenbach)	Sweden		Hansson, 1985
P. populicola (Walker)	Canada, Sweden		Hansson, 1985, 1987
Phanacis sonchi (Stefani)	Austria		Hansson, 1985
Phytoliriomyza hilarella (Zetterstedt)	Sweden		Hansson, 1985
P. melampyga (Loew)	Sweden		Hansson, 1985
P. variegate (Meigen)	Sweden		Hansson, 1985
Phytomyza sp.	England		Hansson, 1985
P. angelicae Kaltenbach	Sweden		Hansson, 1985
P. angelicastri Hering	Sweden		Hansson, 1985
P. anthrisci Hendel	Sweden		Hansson, 1985
P. aquilegiae Hardy	-		Universal Chalcidoidea Database, 2007
P. artemisivora Spencer	Sweden		Hansson, 1985
P. calthophila Hering	Sweden		Hansson, 1985
P. chaerophylli Kaltenbach	Sweden		Hansson, 1985
P. cytisi Brischke	Sweden		Hansson, 1985
P. deciduae	USA		Hansson, 1987
P. horticola Gourea	China (Jiangxi)		Shenq *et al*., 1989; Zhong and Shenq, 1990
	Japan		Takada and Kamijo, 1979
	Sweden		Hansson, 1985
P. ilicis Curtis	USA		Hansson, 1987
P. lappina Goureau	Sweden		Hansson, 1985
P. marginella Fallen	Sweden		Hansson, 1985
P. milii Kaltenbach	Sweden		Hansson, 1985
P. minuscula (Goureau)	Sweden		Hansson, 1985
P. obscurella Fallen	Sweden		Hansson, 1985
P. paniculatae Sasakawa	Japan		Kamijo, 1978
P. periclymeni Hendel	Sweden		Hansson, 1985
P. pubicomis Hendel	Sweden		Hansson, 1985
P. ranunculi Schrank	Japan	predominant	Sugimoto and Ishii, 1979; Sugimoto *et al*., 1982
	Sweden		Hansson, 1985

附表二　（續）
Appendix table 2.　continued

Host	Distribution	Occurrence	References
P. sonchi Robineau-Desvoidy	-		Universal Chalcidoidea Database, 2007
P. spondylii Robineau-Desvoidy	The Netherlands		Hansson, 1985
P. syngenesiae Hardy	Sweden		Hansson, 1985
P. tanaceti Hendel	England		Hansson, 1985
P. tussilaginis Hendel	Sweden		Hansson, 1985
P. vitalbae Kaltenbach	-		Universal Chalcidoidea Database, 2007
unknown	Italy		Burgio *et al.*, 2007
Cecidomyiidae 癭蚋科			
Mayetiola destructor (Say)	-		Universal Chalcidoidea Database, 2007
LEPIDOPTERA 鱗翅目			
Bucculatrigidae 角折蛾科			
Bucculatrix sp.	-		Hansson, 1987; Universal Chalcidoidea Database, 2007
Coleophoridae 鞘蛾科			
Coleophora laricella (Hübner)	Poland		Skrzypczynska, 1978
C. pruniella Clemens	USA		Hansson, 1987
Elachistidae 小潛蛾科			
Biselachista fulgens (Parenti)	-		Universal Chalcidoidea Database, 2007
Elachista cerusella (Hübner)	Sweden		Hansson, 1985
Eriocraniidae 毛腹蛾科			
Eriocrania subpurpurella (Haworth)	-		Universal Chalcidoidea Database, 2007
Gelechiidae 麥蛾科			
Chrysoesthia drurella (Fabricius)	Japan		Ikeda, 1996
C. sexguttella (Thunberg)	Japan		Ikeda, 1996
Microsetia sexguttella Thnbg.	Italy		Hansson, 1985
Gracillariidae 細蛾科			
Cameraria sp.	USA		Hansson, 1987
C. hikosanensis Kumata	Japan		Ikeda, 1996
C. ohridella Desch. & Dimic	Austria		Grabenweger and Lethmayer, 1999
	Hungary		Balázs and Thuroczy, 2000
	Italy		Lupi, 2005
	Macedonia, Serbia, Yugoslavia		Freise *et al.*, 2002

附表二 （續）
Appendix table 2. continued

Host	Distribution	Occurrence	References
Coleophora laricella Hb.	-		CABI, 2006
Leucoptera malifoliella (Costa)	Canada		Hansson, 1987
	Germany		Mey, 1993
Lithocolletis spp.	Europe		Yoshimoto, 1973
L. corylifoliella Hw.	-		Universal Chalcidoidea Database, 2007
Phyllocnistis sp.	Canada		Hansson, 1987
P. citrella Stainton	Israel		Argov and Rössler, 1996
	Italy		Conti *et al*., 2001
	Japan	predominant	Mafi and Ohbayashi, 2004, 2006
	Spain	minor species	Vercher *et al*., 2005
P. labyrinthella (Bjerkander)	Sweden		Sundby, 1957
P. populiella Chambers	-		Universal Chalcidoidea Database, 2007
P. tremulella Fischer von Röslerstamm	-		Boucek and Askew, 1968
P. vitegenella Clemens	-		Marchesini *et al*., 2000
Phyllonorycter sp.	Canada, USA		Hansson, 1987
P. blancardella F.	-		Universal Chalcidoidea Database, 2007
P. cavella (Zeller)	-		Universal Chalcidoidea Database, 2007
P. celtisella Chambers	Canada		Hansson, 1987
P. corylifoliella Hübner	-		Boucek and Askew, 1968; Universal Chalcidoidea Database, 2007
P. crataegella Clemens	USA		Hansson, 1987
P. lyoniae Kumata	Japan		Ikeda, 1996
P. maestingella (Müller)	-		Boucek and Askew, 1968; Universal Chalcidoidea Database, 2007
P. malimalifoliella Braun	Canada		Hansson, 1987
P. oxyacanthae (Frey)	-		Universal Chalcidoidea Database, 2007
P. propinquinella (Braun)	USA		Hansson, 1987
P. sorbi (Frey)	Sweden		Hansson, 1985
P. spinolella (Duponchel)	-		Universal Chalcidoidea Database, 2007
P. tristrigella (Haworth)	Sweden		Hansson, 1985
P. ulmifoliella (Hübner)	-		Universal Chalcidoidea Database, 2007

附表二　（續）
Appendix table 2.　continued

Host	Distribution	Occurrence	References
Heliozelidae 豔小蛾科			
Coptodisca sp.	Canada, USA		Hansson, 1987
Holocacista rivillei (Stainton)	Italy		Alma, 1995
Lyonetiidae 潛蛾科			
Leucoptera laburnella (Stainton)	England, Sweden		Hansson, 1985
L. malifoliella (Costa)	Germany		Boucek and Askew, 1968; Mey, 1993; Universal Chalcidoidea Database, 2007
L. orobi (Stainton)	Sweden		Hansson, 1985
L. scitella Zeller	Romania		Cojocaru, 2000
L. wailesella (Stainton)	Poland		Hansson, 1985
Lyonetia clerkella (L.)	Japan	predominant	Togashi, 1988; Adachi, 1998
L. prunifoliella Hubner	Japan		Ikeda, 1996
L. prunifoliella malinella (Matsumura)	Japan		Kawashima, 1989; CABI, 2006
Tischeria ekebladella (Bjerkander)	Sweden		Hansson, 1985
T. ekebladella (Bjerkander)	Sweden		Hansson, 1985
T. heinemanni Wocke	Sweden		Hansson, 1985
Momphidae 柿實蛾科			
Cosmopterix pulchrimella Chambers	-		Universal Chalcidoidea Database, 2007
Nepticulidae 矮潛蛾科			
Ectoedemia occultella (L.)	-		Herting, 1975; Burks, 1979
E. platanella (Clemens)	USA		Hansson, 1987
E. pulverosella (Staintion)	-		Universal Chalcidoidea Database, 2007
E. rubivora (Wocke)	The Netherlands		Hansson, 1985
Nepticula floslactella Haworth	-		Universal Chalcidoidea Database, 2007
N. lapponica (Wocke)	-		Universal Chalcidoidea Database, 2007
N. lindquisti Freeman	-		Universal Chalcidoidea Database, 2007
N. malella Stainton	-		Universal Chalcidoidea Database, 2007
N. microtheriella Stainton	-		Universal Chalcidoidea Database, 2007

附表二　（續）
Appendix table 2.　continued

Host	Distribution	Occurrence	References
N. salicis (Stainton)	-		Universal Chalcidoidea Database, 2007
N. sorbi Stainton	-		Universal Chalcidoidea Database, 2007
N. tityrella Stainton	-		Universal Chalcidoidea Database, 2007
Stigmella spp.	Europe		Yoshimoto, 1973
Stigmella sp.	Canada		Hansson, 1987
	Japan		Kamijo, 1978
S. aceris (Frey)	-		Boucek and Askew, 1968; Universal Chalcidoidea Database, 2007
S. anomalella (Goeze)	The Netherlands		Hansson, 1985
S. atricapitella (Haworth)	-		Universal Chalcidoidea Database, 2007
S. atricollis (Stainton)	-		Universal Chalcidoidea Database, 2007
S. aucupariae (Frey)	-		Universal Chalcidoidea Database, 2007
S. aurella (Fabricius)	England		Hansson, 1985
S. centifoliella (Zeller)	-		Universal Chalcidoidea Database, 2007
S. crataegella (Klimesch)	Sweden		Hansson, 1985
S. floslactella (Haworth)	England, Sweden		Hansson, 1985
S. freyella (Heyden)	-		Universal Chalcidoidea Database, 2007
S. hemargyrella (Kollar)	Sweden		Hansson, 1985
S. hybnerella (Hübner)	-		Universal Chalcidoidea Database, 2007
S. ignobilella (Stainton)	Denmark		Hansson, 1985
S. lapponica (Wocke)	-		Universal Chalcidoidea Database, 2007
S. malella (Stainton)	Yugoslavia		Hansson, 1985
S. marginicolella Stainton	-		Universal Chalcidoidea Database, 2007
S. microtheriella (Stainton)	The Netherlands, Sweden		Hansson, 1985
S. minusculella (Herrich-Schäffer)	-		Universal Chalcidoidea Database, 2007
S. myrtillella (Stainton)	-		Universal Chalcidoidea Database, 2007
S. nylandriella (Tengström)	-		Universal Chalcidoidea Database, 2007

附表二　（續）
Appendix table 2.　continued

Host	Distribution	Occurrence	References
S. oxyacanthella (Stainton)	Denmark, Sweden		Hansson, 1985
S. plagicolella (Stainton)	Sweden		Hansson, 1985
S. pulverosella (Stainton)	-		Universal Chalcidoidea Database, 2007
S. ruficapitella (Haworth)	Sweden		Hansson, 1985
S. salicis (Stainton)	Sweden		Hansson, 1985
S. sorbi (Stainton)	Sweden		Hansson, 1985
S. splendidissimella (Herrich-Schäffer)	-		Boucek and Askew, 1968; Universal Chalcidoidea Database, 2007
S. tiliae (Frey)	-		Universal Chalcidoidea Database, 2007
S. tityrella (Stainton)	Sweden		Hansson, 1985
S. trimaculella (Haworth)	Sweden		Hansson, 1985
Tischeriidae 冠潛蛾科			
Tischeria sp.	USA		Hansson, 1987
T. angusticolella Dup.	Sweden		Hansson, 1985
T. dodonaea Stainton	-		Universal Chalcidoidea Database, 2007
T. ekebladella (Bjerkander)	Sweden		Hansson, 1985
T. heinemanni Wocke	Sweden		Hansson, 1985
T. malifoliella Clemens	Canada		Hansson, 1987
Yponomeutidae 巢蛾科			
Argyresthia sp.	Canada		Hansson, 1987
COLEOPTERA 鞘翅目			
Bruchidae 豆象科			
Bruchus rufipes Herbst	-		Universal Chalcidoidea Database, 2007
Rhamphus sp.	Europe		Yoshimoto, 1973
Curculionidae 象鼻蟲科			
Ceutorhynchus contractus (Marsham)	Sweden		Hansson, 1985
Orchestes quercus (L.)	-		Universal Chalcidoidea Database, 2007
Rhamphus oxyacanthae (Marsham)	-		Universal Chalcidoidea Database, 2007
R. pulicarius (Herbst)	-		Universal Chalcidoidea Database, 2007
Rynchaenus japonicus (Hustache)	Japan		Ikeda, 1996
R. mutabilis (Boheman)	Japan		Ikeda, 1996

附表二 （續）
Appendix table 2. continued

Host	Distribution	Occurrence	References
R. pallicornis (Say)	USA		Hansson, 1987
R. populi (Fabricius)	-		Universal Chalcidoidea Database, 2007
R. takabayashii (Köno)	Japan		Ikeda, 1996
HYMENOPTERA 膜翅目			
Cynipidae 癭蜂科			
Diplolepis lens Weld	Canada		Hansson, 1987
D. rosaefolii (Cockerell)	Canada		Shorthouse and Brooks, 1998
Tenthredinidae 葉蜂科			
Fenusa pusilla (Lepeletier)	North America		Yoshimoto, 1973
UNKNOWN	Bulgaria, Canary Is., Channel Is., Croatia, Cyprus, Czechoslovakia, Finland, France, Greece, Hungary, Korea, Korea-North, Moldova, Slovakia, Spain, Switzerland, Turkey, Ukraine, USSR		Universal Chalcidoidea Database, 2007

麻痺與死亡狀態，進而證實該蜂產卵方式屬非共育寄生性 (idiobiont)，其取食寄主行爲亦屬殘害寄主 (destructive) 型。

四、底比斯釉小蜂對蔬菜斑潛蠅之抑制能力

室內 25℃ 下，雌蜂一生可產 220 隻子蜂及致死寄主 358 隻，相較寄主蔬菜斑潛蠅每雌一生僅產 84 隻子代成蠅之生殖力 (Chien and Chang, 2007)，顯示底比斯釉小蜂對蔬菜斑潛蠅幼蟲確具強勢之抑制潛能。

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Morphology and Life History of *Chrysocharis pentheus* (Walker) (Hymenoptera: Eulophidae)

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ABSTRACT

Chrysocharis pentheus (Walker) is an arrhenotokous, solitary idiobiont endoparasitoid of *Liriomyza sativae* Blanchard. The capability of the unmated wasp to produce offspring and kill hosts decreased by 81.8 and 66.2%, respectively, when compared to the mated wasp. The female wasp was capable of killing *L. sativae* by parasitizing (65.1%) and host-feeding (34.9%). The host larva became deeply paralyzed without moving and feeding in 3.9 ± 0.4 min after wasp oviposition or died immediately after being fed upon by the wasp. The daily emergence peak was between 0500 and 0700 h while the peak of oviposition and host-feeding was between 0500 and 1300 h. This wasp has host instar preference, with a particular preference to oviposit and host-feed on third instars. At 25°C, the wasp took 13.2 ± 0.1 days to complete the development from egg to pupa. The duration of egg, larval, prepupal, and pupal stages averaged 1.4 ± 0.0, 4.3 ± 0.1, 0.7 ± 0.1, and 6.8 ± 0.1 days, respectively. The survival rate from egg to pupal stage was 95.5 ± 2.1%. When 40-50 3rd instars of *L. sativae* and honey were provided daily, the longevity of female and male wasps averaged 21.9 ± 1.3 and 16.1 ± 1.3 days, respectively. The fertility and the host killing capability for a wasp were 220 ± 32 wasps and 358 hosts, respectively. The female progeny ratio was 0.50 ± 0.03.

Key words: *Chrysocharis pentheus*, *Liriomyza sativae*, morphology, life history, field bean

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